



# Smart SensorWeb

## National Military Sensing Symposium

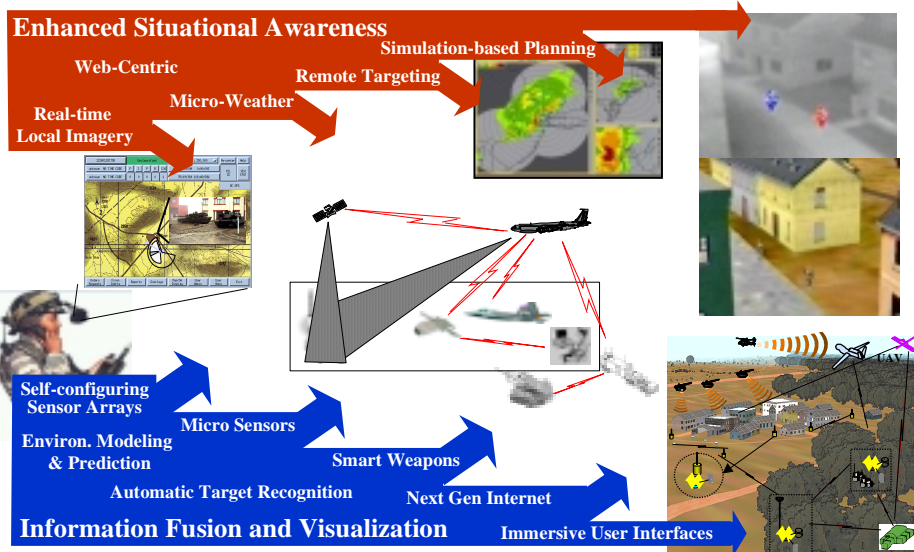
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**Director, Sensor Systems  
Deputy Under Secretary of Defense  
for Science and Technology**

**16 November 1999**



# Smart SensorWeb



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## Smart SensorWeb

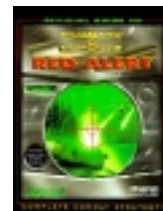
***Vision:*** An intelligent, web-centric distribution and fusion of sensor information . . . that provides greatly enhanced situational awareness, on demand, **to Warfighters at lower echelons.**

“... emphasizes **large arrays of local sensors** joined with other assets: imagery, weather, weapons, simulations, etc. . . .”



## Unprecedented Advances in Commercial Technologies

- Mobile wireless networks
- Micro computers
- Tele-presence
- Geo-location and tracking devices
- Wireless internet connectivity
- Virtual reality (entertainment, video games, immersive interaction)





## Relevant DoD S&T

- **DARPA**
  - Sensor Programs
    - VSAM
    - AVS
    - SensIT
  - Knowledge-Base Programs
    - Dynamic Databases
    - Command Post of the Future
    - Warfighter Visualization
    - Intelligent Integration of Information Technology
    - Rapid Knowledge Formation
  - Comm Network Programs
- **Service Programs**
  - ACTDs: MOUT, ELB, JISR, FMP
  - Warrior Extended Battlespace Sensors
  - Multifunction RF Sensor Technology
  - Cooperative Engagement Capability
  - Battlespace Infosphere
- **DUSD(S&T) Initiatives**
  - Cognitive Readiness, ATR, etc.
- **DMSO**
  - HLA
  - Environmental & HB Reps
- **Basic Research**
  - MURI
    - Data Fusion in Large Array Micro-sensors
    - Mobile Augmented Battlespace Visualization
    - Real-Time Fault-Tolerant Network Protocols
    - Adaptive Mobile, Wireless Networks for Highly Dynamic Environments
  - Basic Research Plan efforts
    - Sensors, algorithms, environmental and cognitive modeling, etc.

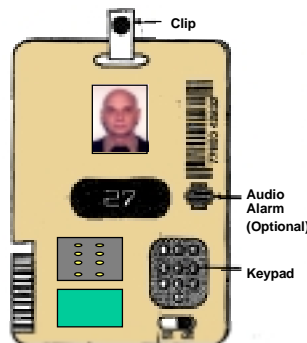


## Force Medical Protection ACTD

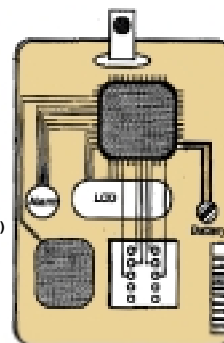


*Providing force protection  
through superior  
technology!*

**Phase I:**  
Chemical Dosimeter  
(Non Real-time)



**Phase II:**  
Chemical Dosimeter (Real-time)/  
Biological Dosimeter  
(Non Real-time)



**Estimated unit cost for production:**  
**Between \$10-\$100 per badge**



## The Evolution

### Sensors...

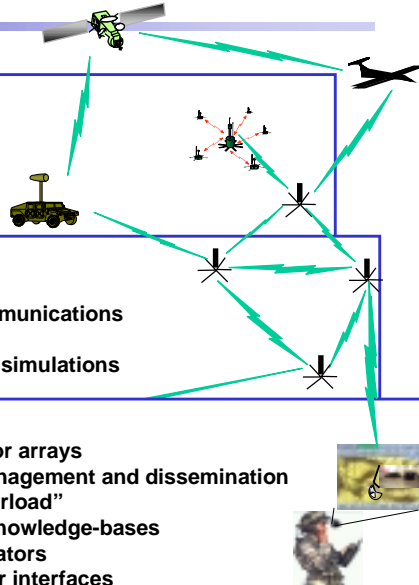
- Multi-domain sensors
- Low cost and micro size
- Capable of target ID (ATR)
- Autonomous & platform based

### SensorWeb...

- Sensor arrays
- Wireless, high-bandwidth communications
- Next Generation Internet
- Efficient links to weapons and simulations

### Smart SensorWeb...

- Adaptive, intelligent sensor arrays
- Intelligent information management and dissemination
  - Avoids "information overload"
- Dynamic databases and knowledge-bases
- Intelligent agents as mediators
- Multi-sensory, natural user interfaces



## Smart SensorWeb: Objectives (FY00 - FY02)

- Identify Warfighter requirements for SSW



- Showcase/illuminate current S&T products and capabilities



- Demonstrate SSW technical feasibility



- Demonstrate enhanced situational awareness

- Assess utility to the Warfighter

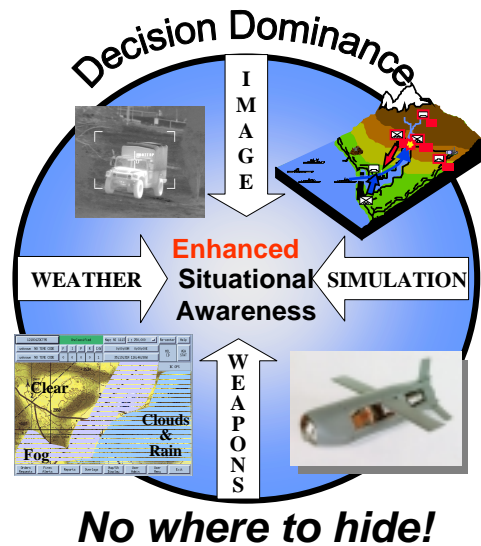
- Identify future research priorities



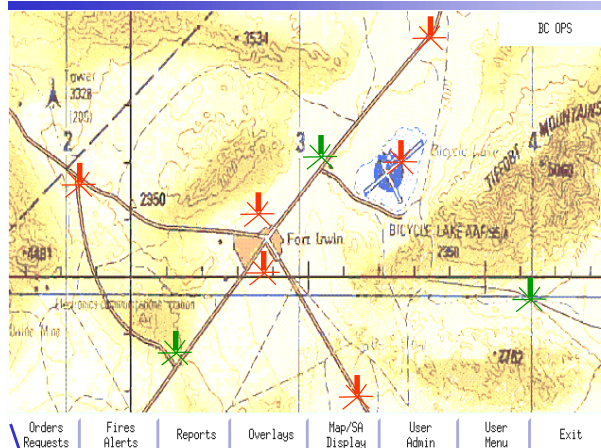


## SSW Elements

- **ImageWeb**
  - Adaptive sensor arrays
  - Intelligent data fusion
- **WeatherWeb**
  - Nowcasts & predictions
  - Dynamic weather effects
- **WeaponsWeb**
  - Sensor-shooter links
  - Optimized engagements
- **SimulationWeb**
  - Simulation-based development
  - Mission planning, rehearsal, & training
- **Information Integration**
  - Info fusion & visualization
  - Data standards



## SSW Concept



### Decision Dominance

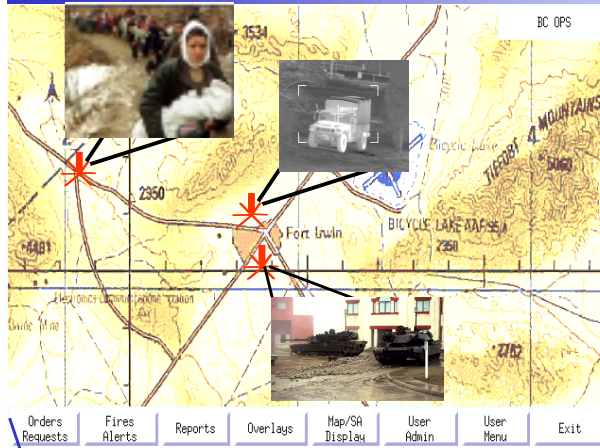
- **ImageWeb**
  - ID Sensor Arrays
  - Add Sensor Arrays







# SSW Concept



## Decision Dominance

- ImageWeb
  - ID sensor arrays
  - Add sensor arrays
  - Sensor alerts
  - Visualize data
  - Obtain images

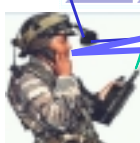


# SSW Concept



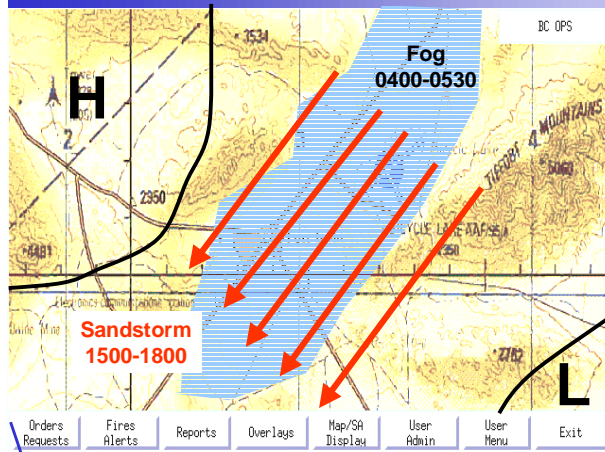
## Decision Dominance

- ImageWeb
  - ID sensor arrays
  - Add sensor arrays
  - Sensor alerts
  - Visualize data
  - Obtain images
- WeaponsWeb
  - Determine threat
  - Friendly situation
  - Engage target
  - Assess damage





# SSW Concept



## Decision Dominance

- ImageWeb
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# SSW Concept



## Decision Dominance

- ImageWeb
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  - Friendly situation
  - Engage target
  - Assess damage
- WeatherWeb
  - Nowcasts & pred.
  - Dynamic effects
- SimulationWeb
  - Fly-through
  - Planning/rehearsal







## Smart SensorWeb: Testbed Approach

☆ **Testbeds** allow a near-term technology “build-and-demonstrate” that **evolves** to the long-term vision

☆ **Four Key Testbed Projects to Demonstrate Capability:**

- ◆ ImageWeb
- ◆ WeatherWeb
- ◆ WeaponsWeb
- ◆ SimulationWeb

Information Integration → Decision Dominance



## Focus on MOUT Scenario

### Center for Army Lessons Learned

- Majority of MOUT casualties due to **inadequate situational awareness**
- Commanders have difficulty “seeing” the fight

### Changing Environments



#### Security Threats

Rogue Nation States/Alliances

International Crime Organizations

Transnational Actors/Terrorists

Weapons of Mass Destruction

#### 21st Century

Conflict Increasing

Proliferation of Military and Commercial Technologies

Operations in Urban Environments

Preponderance of Coalitions

Ethnic Strife

#### Impact

Greater Range of Solutions

No US Monopoly in all Technologies

Complex Targets/Terrain

Information Management Critical



## Smart SensorWeb: Key Players

### ImageWeb:

Dr. Don Reago, Army NVESD  
Ms. Mun-Won Fenton, ONR

### WeatherWeb:

Dr. Douglas Brown, ARL  
Dr. John McCarthy, NRL, Monterey

### WeaponsWeb:

Col Norman Leonpacher, AFRL-Eglin AFB  
Dr. James Chew, ONR

### SimulationWeb:

Mr. William Jarvis, US Army NVESD  
CAPT Robert Eberth, MCWL

### Information Integration:

Mr. John Graniero, AFRL  
Mr. George Lukes, DARPA  
Dr. Lee Hammarstrom, NRO

### Smart SensorWeb:

Dr. Jasper Lupo, DUSD(S&T)/SS  
Dr. Charles Holland, DUSD(S&T)/IS  
LTC Bruce Gwilliam, DUSD(S&T)/SS  
Mr. Jeff Paul, DUSD(S&T)/SS  
Mr. Marshall Potter, DUSD(S&T)/IS  
CAPT David Martin, DUSD(S&T)/IS

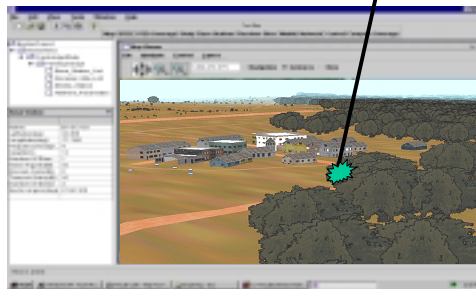
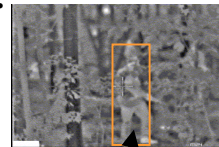


## ImageWeb Year 1 - Web on Line

### Point, click and see in an urban environment:

- Priority alert to operator
- 3-D visualization
- Multiple sensors
  - IR/EO,
  - acoustic, &
  - seismic
  - $\mu$ -sensors
- Internet/LAN real-time access
- Images registered to site map (Compact Terrain Data Base)
- Target classification
- Target geolocation
- Target tracking
- Target hand-off

Alerting icon queried  
for imagery

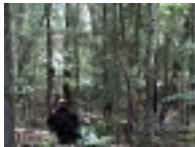




## Year 2 - ImageWeb Assistant

Building on Year 1 to automate target of interest detection/recognition and tracking

- Data fusion between multiple viewpoints
- Multi-modal data fusion (thermal /daylight)
- Random sensor placement experiments
- Weather Web integration
- Image to model registration
- MTI/Change Detection/Cross-cueing
- Sensor arbitration for 'best view'
- Geolocation via N-camera registration
- Simulation integration via HLA protocol



Multi-modal Data Fusion

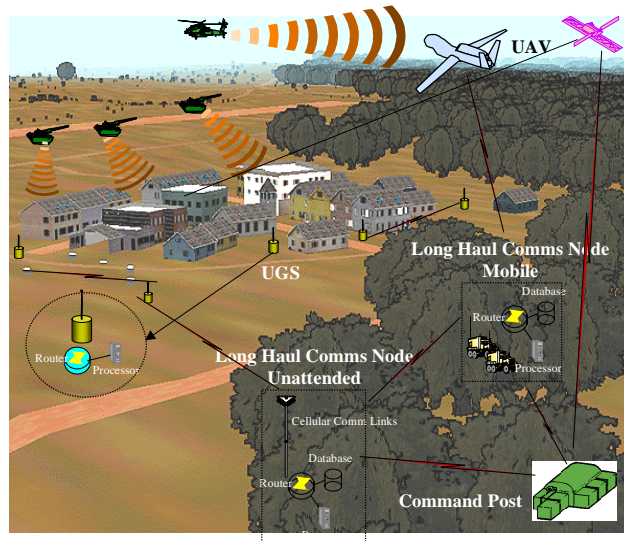
Image to model registration



## Year 3 - Intelligent Image Agent

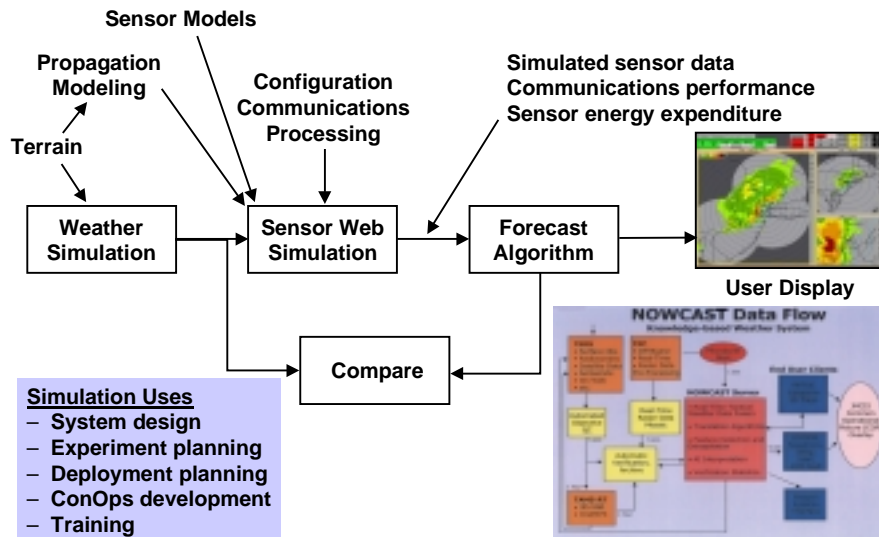
### Smart Sensor Webs

- Mobile Ad Hoc Network
- Air dropped sensors
- Tactical mobile robots
- Multi-sensor coordination
- Leveraging DARPA's SUO, IU, DDB, MEMS Programs
- Novel sensors
- Managed video/data streams
- Tactical sensor integration
- 4-D model - live simulation

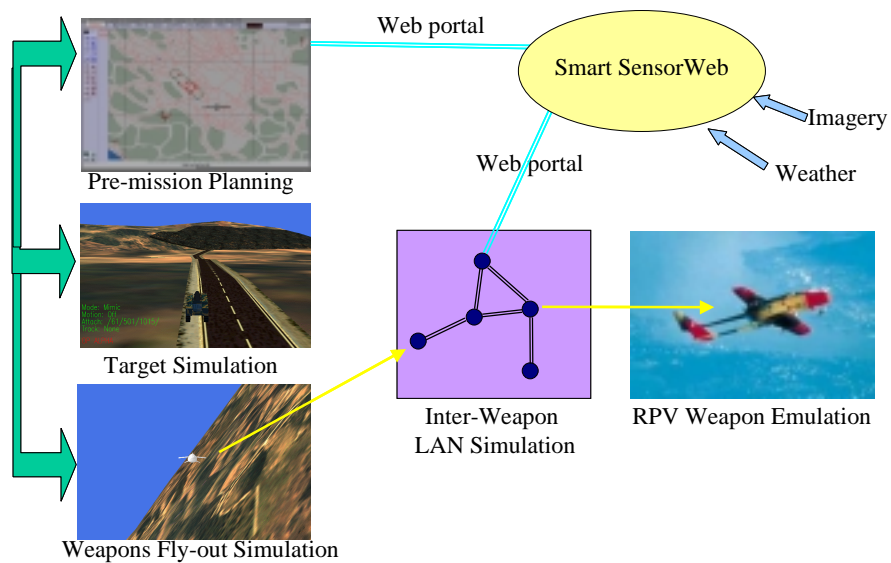




## WeatherWeb

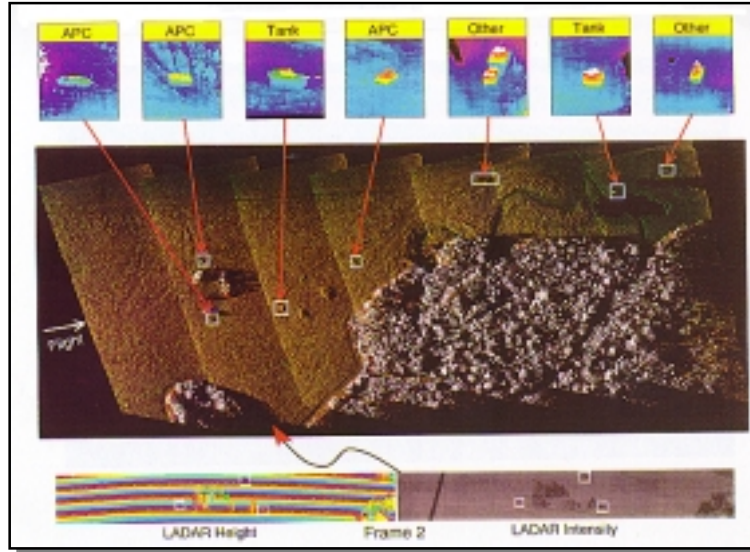


## WeaponsWeb

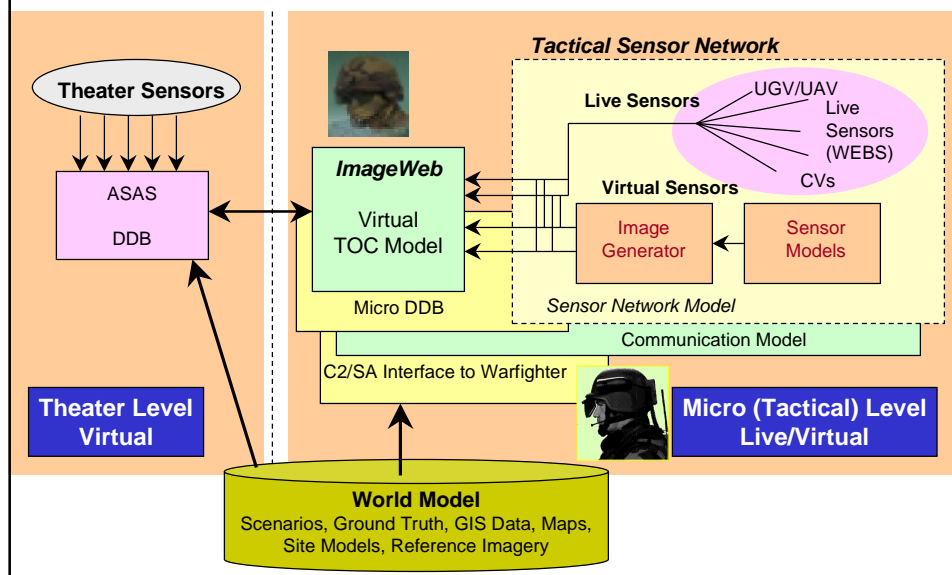




## LADAR Automatic Target Recognition Captive Flight Test Results



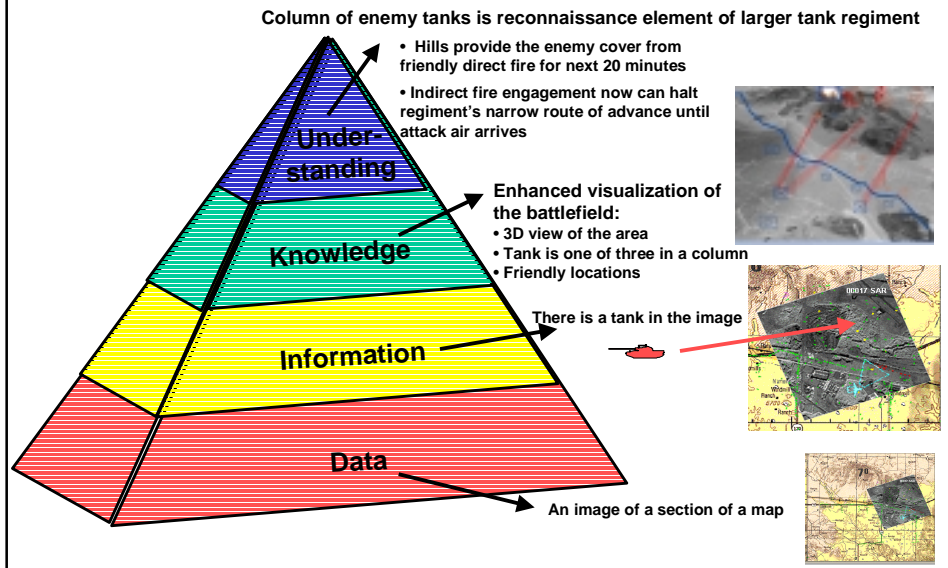
## SimulationWeb





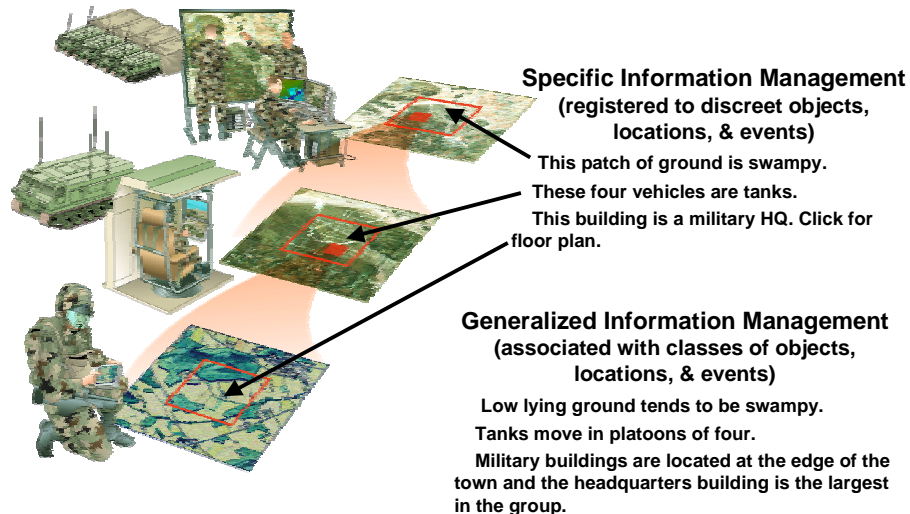


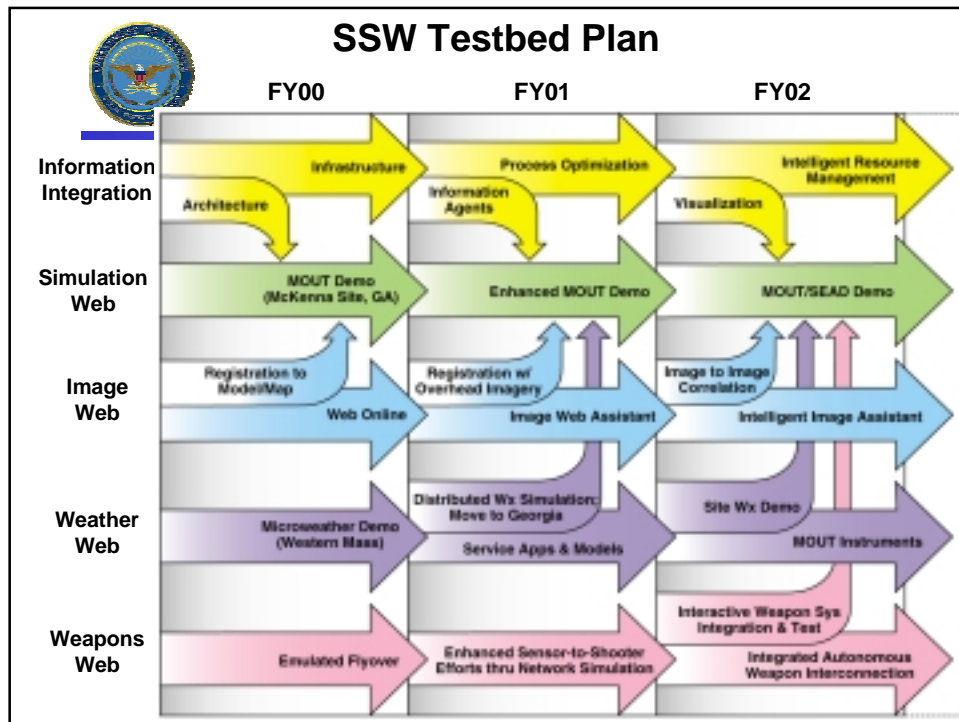
# SSW: From Data to Understanding




## Managing SSW Information

### Approaches for Handling Information








## Summary

- **Broad initiative**
  - Large arrays of local sensors
  - Testbed emphasis to prove concept
- **Leverages DoD and commercial investments**
- **Long term research opportunities**

**Operational Decision Dominance**



***“seeding” the battlefield with a network of distributed sensors***

